Stock Composition of Northumberland Strait, Nova Scotia Atlantic Salmon (Salmo Salar) Commercial Fisheries

By

R.R. Claytor, C.E. Léger, and R.W. Gray

Department of Fisheries and Oceans
Science Branch
Gulf Region
P.O. Box 5030
Moncton, New Brunswick E1C 9B6

June 1987

Canadian Technical Report of Fisheries and Aquatic Sciences

No. 1563

Fisheries and Oceans Pêches et Océans

Canada

88-02185/

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1–456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457–714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. Numbers 715–924 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annual des publications scientifiques et techniques du Ministère.

Les numéros 1 à 456 de cette série ont été publiés à titre de rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Technical Report of

Fisheries and Aquatic Sciences No. 1563

June 1987

STOCK COMPOSITION OF NORTHUMBERLAND STRAIT, NOVA SCOTIA ATLANTIC SALMON (*Salmo salar*) COMMERCIAL FISHERIES

by

R.R. Claytor, C.E. Léger, and R.W. Gray

Department of Fisheries and Oceans

Science Branch

Gulf Region

P.O. Box 5030

Moncton, NB E1C 9B6

(c) Minister of Supply and Services Canada 1987

Cat. No. Fs 97-6/1563E ISSN 0706-6457

Correct citation for this publication is:

Claytor, R.R., C.E. Léger, and R.W. Gray. 1987. Stock composition of Northumberland Strait, Nova Scotia Atlantic salmon (Salmo salar) commercial fisheries. Can. Tech. Rep. Fish. Aquat. Sci. No. 1563: viii + 19 p.

CONTENTS

List of Tables iv

List of Figures vi

Abstract/Résumé vii

Introduction 1

Materials and Methods 1

Results and Discussion 2

References 4

LIST OF TABLES

Table 1. Atlantic salmon data sets comprised of known river origin and Statistical Districts 12 and 13 commercial fisheries sampled in 1983. Locations shown in Figure 1. 6

Table 2. Scale character definitions and abbreviations used in analysis of Atlantic salmon from Statistical Districts 12 and 13, Miramichi River, New Brunswick and four Nova Scotia rivers. 7

Table 3. Age structure of known river origin Atlantic salmon, 1983. ... 8

Table 4. Age structure of Atlantic salmon caught in Statistical Districts 12 and 13 commercial fisheries, 1983. 9

Table 5. Age-group means of Atlantic salmon from River Philip, Nova Scotia. * indicates characters for which differences were significant ($p < 0.01$) between age-groups. There were no differences between sexes for any characters. Abbreviations as in Table 2. 10

Table 6. Significant differences, *, ($p < 0.01$) among groups and between river ages for Atlantic salmon of known river origin from Nova Scotia East, River Philip, Millbank, Black Brook, Eel Ground, and St. Georges Bay and coastal areas of Statistical Districts 12 and 13. 11

Table 7. Mean fork length of Atlantic salmon of known river origin from pooled Nova Scotia and Miramichi samples, Statistical Districts 12 and 13, 1983, and Millbank trapnet, 1986. * indicates groups not significantly different ($p < 0.01$) within years. There were no significant differences between sexes within groups. 12

Table 8. Discriminant functions derived from "learning" samples of Atlantic salmon of known river origin. Abbreviations as in Table 2. Letters refer to learning and test data sets used in discriminant function analysis. 13

Table 9. Standardized coefficients for canonical variables from discriminant analysis on "learning" samples of Atlantic salmon of known river origin. Letters correspond to discriminant functions in Table 8. Abbreviations as in Table 2. 13

Table 10. Percentage of individuals in Statistical Districts 12 and 13 Atlantic salmon commercial fisheries estimated as originating within Nova Scotia or Miramichi homewaters. Percentage and 95% confidence intervals calculated from $\tilde{\theta}$ and $\Sigma\,\tilde{\theta}$ using pairs of estimates within each age-group class as described by Pella and Robertson (1979). 14

Table 11. Numbers of Atlantic salmon in each "test" sample assigned by discriminant functions in Table 9 to Nova Scotia and Miramichi origin. 14

Table 12. Numbers of Atlantic salmon from Statistical Districts 12 and 13 commercial fisheries assigned to Nova Scotia or Miramichi origin by discriminant functions in Table 9. 15

Table 13. Summary of tagged and marked recaptures of Atlantic salmon for all age-classes of Miramichi, Margaree, and Philip rivers origin. Years refer to recapture times. 15

Table 14. Mean scale characteristics for 1986 Margaree and 1983 Nova Scotia East, River Philip, and Miramichi returns. 16

Table 15. Mean temperatures from 1983 monitoring sites in areas of possible migration for Atlantic salmon caught in Statistical Districts 12 and 13 commercial fisheries and those sampled from Miramichi and Nova Scotia rivers. 16

LIST OF FIGURES

Figure 1. Location of rivers, commercial fisheries, Statistical Districts, and temperature stations sampled in 1983. Key to locations are in Table 1. SD12, Statistical District 12; SD13, Statistical District 13. Letter refers to temperature monitoring stations: A, Beach Point, PEI; B, Borden, PEI; C, Egmont, PEI; D, Victoria, PEI; E, West Point, PEI; F, Grande Entree, Iles de la Madelaine; G, Havre aux Maison, Iles de la Madelaine. 17

Figure 2. Means and significant differences among Atlantic salmon of known river origin and Statistical Districts 12 and 13 for freshwater zone scale characteristics. Locations sharing common line are not significantly different ($p < 0.01$). Locations are listed from lowest to highest values for each character. Character abbreviations as in Table 2. 1B, St. Georges Bay sites 1-5; OB, coastal fishery sites 6-12. ... 18

Figure 3. Means and significant differences among Atlantic salmon of known river origin and Statistical Districts 12 and 13 for sea zone scale characteristics. Locations sharing common line are not significantly different ($p < 0.01$). Locations are listed from lowest to highest values for each character. Character abbreviations as in Table 2. 1B, St. Georges Bay sites 1-5; OB, coastal fishery sites 6-12. ... 19

ABSTRACT

Claytor, R.R., C.E. Léger, and R.W. Gray. 1987. Stock composition of Northumberland Strait, Nova Scotia Atlantic salmon (Salmo salar) commercial fisheries. Can. Tech. Rep. Fish. Aquat. Sci. No. 1563: viii + 19 p.

Scale samples from Atlantic salmon (Salmo salar) caught in Northumberland Strait, Nova Scotia commercial fisheries, as well as salmon returning to Miramichi, New Brunswick and four Northumberland Strait, Nova Scotia rivers, were collected in 1983. Circuli counts and distance measurements in freshwater, first sea summer and first sea winter zones were used to differentiate stock origin of the commercial catch. Only virgin 2SW salmon were analyzed, as they comprised most of the commercial catch. There were no significant differences between sexes. However, 2+ had lower values than 3+ smolts for every character. As a result, discriminant function analysis was performed separately on these two river age-groups. Circuli counts in the first sea summer zone, and distance measurements in the second river, first sea summer, and first sea winter zones were the most important characters in differentiating stocks. River Philip and Miramichi stocks were at opposite extremes of a stock continuum, on which the remaining Northumberland Strait, Nova Scotia salmon were intermediate. Less than 30% of the salmon caught in Northumberland Strait, Nova Scotia commercial fisheries were of local origin.

RÉSUMÉ

Claytor, R.R., C.E. Léger, and R.W. Gray. 1987. Stock composition of Northumberland Strait, Nova Scotia Atlantic salmon (Salmo salar) commercial fisheries. Can. Tech. Rep. Fish. Aquat. Sci. No. 1563: viii + 19 p.

En 1983, on a recueilli des échantillons d'écailles du saumon de l'Atlantique (Salmo salar) capturé dans le détroit de Northumberland, par les pêcheurs commerciaux de la Nouvelle-Ecosse ainsi que du saumon remontant la Miramichi, au Nouveau-Brunswick et quatre rivières tributaires du détroit de Northumberland, en Nouvelle-Ecosse. Afin de distinguer les divers stocks d'origine des saumons qui composaient les prises commerciales, on a compté les stries d'accroissement des écailles et on a pris les mesures pertinentes sur les saumons d'eau fraîche, les saumons d'un été en mer et les saumons d'un hiver en mer. En ce qui concerne les saumons de deux hivers en mer, on n'a analysé que les poissons vierges puisqu'ils composaient la plus grande partie de la prise commerciale. On a remarqué très peu de différence entre les sexes. Par ailleurs, les tacons de 2 ans en eau fraîche avaient de plus faibles valeurs que les tacons de 3 ans en eau fraîche pour chaque caractéristique de l'écail. Par conséquent, une analyse des fonctions discriminantes a été exercée séparément sur ces deux groupes d'âge ayant

vécu dans la rivière. Le compte des stries d'accroissement sur les poissons d'un été en mer et la mesure des distances sur les saumons de deux printemps en eau fraîche, les saumons d'un été en mer et les saumons d'un hiver en mer étaient les caractéristiques les plus importantes pour différencier les stocks. Les stocks de River Philip et de la Miramichi étaient aux deux extrémités d'un continuum et les autres saumons du détroit de Northumberland en Nouvelle-Écosse se trouvaient au point intermédiaire. Moins de 30 % du saumon capturé dans le cadre de la pêche commerciale du détroit de Northumberland en Nouvelle-Écosse étaient d'origine locale.

INTRODUCTION

One of the major challenges facing the management of Atlantic salmon (Salmo salar) is estimating the stock mixture of commercial fisheries. Commercial salmon fisheries in the Maritimes were closed in 1985, nevertheless, the composition of these fisheries is important for assessing productivity and the impact of this management strategy on subsequent returns to contributing rivers. This investigation examines the 1983 contribution of Miramichi River, New Brunswick and Northumberland Strait, Nova Scotia salmon to commercial fisheries in Statistical Districts 12 and 13, Northumberland Strait, Nova Scotia. Commercial fishing in this area occurred during June and July and in 1983 the fourth largest catch of salmon in the Maritime portion of the Gulf of St. Lawrence was recorded in District 13 (O'Neil et al. 1983).

Salmon harvested in these fisheries are likely a mixture of several stocks. Most salmon do not return to rivers in the Northumberland Strait, Nova Scotia, until October or November (Chadwick et al. 1985). Alternatively, salmon return to many Gulf rivers outside these Districts before September 1, such as the Miramichi River in New Brunswick and Margaree River in Nova Scotia (Chadwick et al. 1985; Claytor and Léger 1986). However, tagging studies indicate that salmon from each of these areas are caught in Districts 12 and 13 during June and July (Saunders 1969; Kerswill 1971; Marshall 1979).

Scale characters were chosen to differentiate stock origins because they are easy to collect and are useful for identifying continental and local origins of Atlantic and Pacific salmon (Oncorhynchus sp.) (Amos et al. 1963; Lear and Sandeman 1980; Cook 1982; Reddin and Misra 1985). Clinal variation among North American salmon has also been reported (Lear and Misra 1978). Therefore, scale characteristics should be useful for delineating stock origins of Atlantic salmon taken in District 12 and 13 commercial fisheries.

MATERIAL AND METHODS

SAMPLE COLLECTION

Scales were collected in 1983 from 256 Atlantic salmon caught in commercial fisheries of Statistical Districts 12 and 13 and from 232 salmon returning to the Miramichi River, New Brunswick and four Nova Scotia rivers (Fig. 1, Table 1). These samples represent 14% of the commercial and 8% of the recreational catch from these areas. The commercial fisheries were sampled in fish plants or directly from fishermen in the designated communities and as a result are representative of fish caught in these locations. Scales were removed from above the lateral line in the area between the posterior of the dorsal fin and anterior of the anal fin (Lear and Sandeman 1980) and mounted smooth side-up on acetate slides.

VARIABLES MEASURED

A Bausch and Lomb vertical microprojector (Model No. 42-63-60) was used to project a scale image onto a white paper surface. A 12X objective lens was used and gave a magnification of 45X. The vertical distance between the slide platform and the projected image was 50 mm.

To standardize counts and measurements, four axes were drawn from a common origin on the paper surface at 0°, 30°, 45°, and 60°. Each scale was projected with its focus at this origin and longest axis corresponding to 0°. Along the 45° axis, circuli were counted within the freshwater, the estuarine, the first sea summer, and the first sea winter zones. The first circulus which was noticeably closer to its neighbor, marked the end of each summer zone. The first circulus which was noticeably farther from its neighbor, marked the beginning of each summer zone. The area between marked the winter zone. In each case circuli are counted from the focus to the outer edge of the scale. These criteria are consistent with those used in previous examinations of Atlantic salmon scales to discriminate stocks (Reddin and Misra 1985). Along each of the 0°, 30°, and 60° axes the distance from the focus to last circulus of the above zones was measured to the nearest 0.05 mm on the projected image using vernier calipers. Regenerated scales were not used in the analysis. Character definitions and abbreviations are described in Table 2.

All fish were measured to the nearest centimetre for fork length. Fish sampled at Millbank trap (Fig. 1) were weighed to the nearest 10 g. Salmon from Districts 12 and 13 and Eel Ground (Fig. 1) commercial fisheries which had not been gutted were also weighed. The weights of fish caught in sport fisheries were estimated by anglers. Sex was determined using internal characteristics.

Tag return information from Department of Fisheries and Oceans files concerning kelts from the Miramichi, Margaree and Philip rivers between 1913-1943, Margaree smolts in 1976, and literature reports by Saunders (1969) and Kerswill (1971) assisted in interpreting the proportions derived from the analysis of scale characteristics.

Temperature data collected in 1983 from monitoring sites at depths < 14 m (Dobson and Petrie 1984) were used to infer temporal and spatial migratory patterns of salmon caught in Districts 12 and 13.

AGE-CLASS, SEX, SEASONAL, AND SPATIAL VARIATION

Age-group designations were as follows: 2.2 refers to salmon leaving freshwater as 2+ smolts and returning to spawn for the first time after two sea winters. Similarly, 3.2 refers to salmon leaving freshwater as 3+ smolts and returning to spawn for the first time after two winters at sea. Fish migrating to sea as 2+ and 3+ smolts were the predominant river age-classes in all samples. In addition, most of the salmon sampled in all fisheries had spent two winters at sea. For example, 83% of the sport and 84% of the commercial fishery samples were either 2.2 or 3.2 age-classes (Tables 3, 4). As a result, analyses were restricted to these age-classes and include only virgin 2SW salmon.

A 4-5 cm difference in fork length was observed between salmon caught in the commercial

fishery and those returning to home rivers. The possibility that this character could be used to supplement the findings of scale characters was also investigated. To do this it was necessary to determine if seasonal or sexual variation were factors influencing fork length. Samples collected at Millbank, Northwest, and Southwest, Miramichi River Department of Fisheries and Oceans trapnets in 1986 were used for this purpose. Samples collected in 1986 were used as there were few returns to this river during September and October in 1983 (Chadwick et al. 1985). Samples were divided into three groups, those captured from June-August, September, and October. A two factor ANOVA on these samples, with timing and sex as class variables was used to test for seasonal and sexual variation in fork length.

To determine if samples could be pooled by sex and river age within locations a two factor ANOVA was used to test for significant differences in scale characteristics, fork length and weight on the River Philip sample. Only this sample had sufficient numbers of each sex and river age to do this analysis.

Because few samples were available from the West River, Antigonish; East River, Pictou; and Wallace River (Table 3), these sites were pooled into a single Nova Scotia East group. As a result, five known origin groups, Nova Scotia East, River Philip, Millbank, Black Brook, and Eel Ground were examined for significant differences in scale characteristics, fork length, and weight by river age.

Scale characteristics, fork length, and weight differences were also examined by river age between salmon caught in St. Georges Bay (sites 1-5, Fig. 1) and the Coastal Fishery (sites 6-12, Fig. 1). This separation was examined to determine if salmon caught in the bay were representative of a stock which differed from those taken outside the bay. If these fish represent separate stocks, hypotheses concerning the differential origin of salmon caught in these areas would need to be investigated.

STATISTICAL ANALYSIS - UNIVARIATE

Measurements of skewness, kurtosis, Shapiro-Wilks (W) statistic, and normal probability plots were used to test for univariate normality for all distance measurements. SAS UNIVARIATE (Joyner et al. 1985) was used for these tests. A Log_{10} transformation was used to achieve normality for all distance measurements, even though it was not required for each character. On completion of analyses, mean values for each distance character were converted to standard notation. Residuals were examined to identify outliers. No residuals > 3 standard deviations from the mean were found.

A transformation useful for producing normality in circuli counts, which are discrete variables, could not be found. The analyses applied in this investigation are robust to deviations from normality (Sokal and Rohlf 1981) and have been performed without transformation of these discrete characters (Ihssen et al. 1981).

All univariate analyses were done using SAS (Joyner et al. 1985) procedures. All significant levels were evaluated at $p < 0.01$.

STATISTICAL ANALYSIS - MULTIVARIATE

"Learning" and "test" data sets as described by Cook and Lord (1978) were formed from the known origin samples. These data sets were created by separating 2+ and 3+ river age-groups and randomly placing half the fish from each into separate data sets. As a result, there were two data sets each for 2+ and 3+ river age salmon. Each of the pairs of river age data sets was used as a "learning" sample for the other, of the same age, as described by Pella and Robertson (1979). This permitted pairs of estimates concerning the stock origin of Districts 12 and 13 commercial fisheries ($\hat{\beta}$ of Pella and Robertson 1979) and two estimates of the variance associated with $\Sigma \hat{\beta}$. The use of mean estimates in this manner ".. provides an unknown but greater level of confidence" than the use of estimates derived from single "learning" samples (Pella and Robertson 1979). The reason for separating 2+ and 3+ river age-groups is explained in Results and Discussion.

BMDP (Dixon et al. 1983) was used to calculate all discriminant functions. This program eliminates cases which have missing values for any character. Hence, sample sizes were unequal in some instances. A stepwise procedure is often used with discriminant function analysis to select important characters. However, character selection by this method can be sample dependent (Humphries et al. 1981). In this investigation, a uniform character set was necessary because several data sets were involved in deriving the discriminant functions. Hence, characters were selected using the two factor ANOVA on known origin samples described above (Cook and Lord 1978). Characters were used only if means for each Nova Scotia and all Miramichi groups were different and if there was a significant difference among the locations within at least one age-group. The characters chosen were then forced into the discriminant model. This method provides a "best average" character set for differentiating stocks and maintains consistency among pairs of "learning" and "test" data sets.

RESULTS AND DISCUSSION

Analysis of River Philip salmon indicated that 2.2 and 3.2 age-groups be analyzed separately but that sexes could be pooled. For every scale character, values for the 3.2 age-group were less than those for 2.2 aged salmon. For characteristics in the second freshwater zone these differences were significant (Table 5). However, there were no significant differences between sexes for any character.

Examination of five known origin groups and the commercial fishery also supports a separate analysis of 2.2 and 3.2 age-groups. Significantly lower values for all characters of the 3.2 compared to 2.2 age-group in the second freshwater zone and for CSS were found regardless of origin (Table 6; Figs. 2 and 3).

Nova Scotia salmon sampled in October had significantly greater fork lengths than those from Miramichi and Districts 12 and 13 (Table 7).

However, this difference was attributed to seasonal effects and could not be used to differentiate stocks. Salmon returning to the Miramichi River in October had significantly greater fork lengths than those from June-September (Table 7).

River Philip salmon had the highest values for 22/28 characteristics. For seven of these they were significantly greater than all Miramichi samples. In contrast, River Philip had significantly greater values than Nova Scotia East salmon for only two characters (Figs. 2 and 3). This result suggests that Nova Scotia East salmon are intermediate in a continuum that has Miramichi and River Philip stocks at opposite extremes.

River Philip and Nova Scotia East groups had greater values for scale characteristics than the three Miramichi samples for 12/16 sea zone and 5/12 second and third freshwater zone features. Within age-groups there were no significant differences among Miramichi samples for any character with the exception of CR3 (Figs. 2 and 3). Hence, River Philip and Nova Scotia East were pooled into one regional stock (Nova Scotia) and salmon sampled at Millbank, Black Brook, and Eel Ground into another (Miramichi).

There was no indication that salmon caught in St. Georges Bay and coastal portions of Districts 12 and 13 represent different stocks. Significant differences between these groups were found in only 2/28 characters (Figs. 2 and 3).

Characters chosen to enter the discriminant function model were CSS, DSS30, and DSW30 for both age-groups, with DR230 added to the 3.2 age-group model (Table 8). These characters were chosen for three reasons. Firstly, there were significant differences among the groups for each of these characters. Secondly, Nova Scotia had higher values than Miramichi salmon for every measurement along the 30° axis and for CSS regardless of age-group. Thirdly, this separation was not consistently defined for measurements along any other axis. The only exception, DR230 for the 2.2 age-group, was not included in the model (Figs. 2 and 3). Thus, a uniform set of characters within each age-group, with maximum potential for separating stocks was used to derive the discriminant functions.

Within the 2.2 age-group DSW30 was the most important character contributing to Nova Scotia versus Miramichi separation and CSS the least. Within the 3.2 age-group, DSS30 and DSW30 were most and CSS least important in differentiating stocks (Table 9). Hence, measurements or estimates of shape are likely to be more useful than counts for differentiating closely related stocks. For example, circuli (Lear and Sandeman 1980) and meristic counts are as useful as morphometrics for distinguishing continental origin of Atlantic salmon (Claytor 1984). However, morphometrics are superior to meristics in differentiating stocks within North American (Claytor 1984) and Baltic (MacCrimmon and Claytor 1985) regions.

Less than 10% of the 2.2 age-group and < 30% of the 3.2 age-group were identified as Nova Scotia origin. While confidence intervals for these proportions were large, a higher percentage of Miramichi compared to Nova Scotia salmon were identified in the commercial fisheries by each discriminant function (Table 10). If this is found to be true for other years, it would mean that the majority of salmon caught in Districts 12 and 13 are of non-local origin (i.e. originate from rivers other than Northumberland Strait, Nova Scotia).

A possible objection to this conclusion concerns the River Philip sample. This stock comprises 70% of 2.2 and 75% of 3.2 age-group samples of Nova Scotia origin (Table 3). Because salmon from Nova Scotia East rivers are intermediate stocks, this sampling bias would tend to skew Nova Scotia means toward the River Philip extreme. Because River Philip salmon are so different from those taken in the commercial fishery, this skewness could make it more difficult to identify fish of local origin.

Nevertheless, indications are that this sampling bias is of less concern than would be indicated by the stock relationships. Firstly, all means for characters used in the discriminant functions of salmon caught in Districts 12 and 13 are below those of Nova Scotia East samples (Figs. 2 and 3). Secondly, the highest degree of accuracy was in identifying fish of Nova Scotia origin (Table 11). Therefore, fish are more likely to be misidentified as being of Nova Scotia rather than Miramichi origin. Thirdly, errors in misclassification of Nova Scotia fish using data sets A, B, and C were equally divided between Nova Scotia East and River Philip salmon. In data set D (Table 11) 7/10 errors were among River Philip fish. Fourthly, the learning sets were consistent in predicting origin of salmon caught in Districts 12 and 13 (Table 12). Hence, the intermediate status of Nova Scotia East and the sampling bias towards River Philip salmon does not appear to have differentially influenced assigned origins.

A second objection arises by examining tag returns from rivers contributing to Districts 12 and 13. Tag returns are few but indicate that fish of Margaree, as well as Miramichi and River Philip origin, contribute to these fisheries (Table 13). Samples of 1983 Margaree returns were not available for inclusion in the discriminant analysis. Hence, it is difficult to determine what proportion, if any, of the fish identified as Miramichi or Nova Scotia might actually be of Margaree origin.

Scales collected from Margaree returns in 1986 can be used to provide a qualitative prediction of this proportion. However, this comparison assumes that scale characteristics will be consistent among years. Because there is no evidence supporting or refuting this assumption it should be interpreted with caution. This concern was the reason that 1986 Margaree scale samples were not included in the discriminant analysis. Means of Margaree salmon for DSS30, DSW30, and DR230 are more similar to Nova Scotia East or River Philip than those of Miramichi origin. Only for CSS, the least important character, were Margaree most similar to Miramichi salmon (Table 14). Thus if differences are consistent among years, Margaree are more similar to Nova Scotia than Miramichi salmon. Therefore, it is more likely that Margaree salmon are included in Nova Scotia, rather than Miramichi assignments and that fish taken in Districts 12 and 13 are primarily of Miramichi origin.

That many fish caught in Districts 12 and 13

are of non-local origin has important implications concerning migration patterns of salmon returning to Northumberland Strait, Nova Scotia rivers. The lack of a commercial fishery in Northumberland Strait west of District 12 in June-July (O'Neill et al. 1983) suggests that there is little movement of salmon in this area at that time. This lack of movement through the strait may be limited by temperatures which do not fall below June-July levels until October (Table 15). This assumption is also supported by the lack of an early run for all Northumberland Strait, Nova Scotia rivers. Returns to these rivers do not peak until late October and early November. For example, returns to South River, Antigonish typically peak the first week in November (Chadwick et al. 1985). The lack of salmon bound for Northumberland Strait, Nova Scotia rivers in these fisheries suggests they arrive after July rather than hold in St. Georges Bay area from June to October. However, the lack of an alternative migration hypothesis for these fish is a difficulty in proposing a more definitive interpretation.

A clearer definition of relationships among the stocks will help resolve the relative contributions of Margaree, Miramichi, and Nova Scotia rivers and possible migration patterns of salmon taken in Districts 12 and 13. This definition requires increasing the sample size of Districts 12 and 13 homewaters, as well as sampling fish of Margaree origin. Experimental tagging of salmon caught in these fisheries and comparing location of returns would also be of value. From these preliminary findings, it appears that a large proportion of salmon harvested in Districts 12 and 13 are of non-local origin. As a result, future management of these fisheries may need to consider not only the status of Northumberland Strait, Nova Scotia salmon stocks, but also those of Miramichi and Margaree origin.

ACKNOWLEDGEMENTS

Dave Reddin and Mike Chadwick provided useful comments for early drafts. We would also like to thank all commercial fishermen and anglers for help in obtaining scale samples.

REFERENCES

Amos, M.H., R.E. Anas, and R.E. Pearson. 1963. Use of a discriminant function in the morphological separation of Asian and North American races of pink salmon, Oncorchynchus gorbuscha (Walbaum). Int. North Pac. Fish. Comm. Bull. 11:73-100.

Chadwick, E.M.P., D.R. Alexander, R.W. Gray, T.G. Lutzac, J.L. Peppar and R.G. Randall. 1985. 1983 Research on anadromous fishes, Gulf Region. Can. Tech. Rep. Fish. Aquat. Sci. No. 1420:xi + 69 p.

Claytor, R.R. 1984. The taxonomy of Atlantic salmon, Salmo salar Linnaeus: a species description to the stock concept. M.Sc. thesis, University of Guelph, Guelph, Ontario. 136 p.

Claytor, R.R., and C. Léger. 1986. Assessment of Atlantic salmon, Salmo salar, in the Margaree River, Nova Scotia, 1986. CAFSAC Research Document 86/93.

Cook, R.C. 1982. Stock identification of sockeye salmon (Oncorhynchus nerka) with scale pattern recognition. Can. J. Fish. Aquat. Sci. 39:611-617.

Cook, R.C., and G.E. Lord. 1978. Identification of stocks of Bristol Bay sockeye salmon, Oncorhynchus nerka, by evaluating scale patterns with a polymonial discriminant method. Fish. Bull. 76(2):415-423.

Dixon, W.J., M.B. Brown, L. Engelman, J.W. Frane, M.A. Hill, R.I. Jennrich, J.D. Toporek. 1981. BMDP Statistical Software 1981. Univ. Calif. Press, Berkeley, Calif. 725 p.

Dobson, D., and B. Petrie. 1984. Long-term temperature monitoring program, 1983, Scotia-Fundy, Gulf Regions. Can. Data Rep. Hydrogr. Ocean Sci. 22:vi + 406 p.

Humphries, J.M., F.L. Bookstein, B. Chernoff, G.R. Smith, R.L. Elder, and S.G. Poss. 1981. Multivariate discrimination by shape in relation to size. Syst. Zool. 30:291-308.

Ihssen, P.E., D.O. Evans, W.J. Christie, J.A. Reckahn, and R.L. Desjardins. 1981. Life history, morphology and electrophoretic characteristics of five allopatric stocks of lake whitefish (Coregonus clupeaformis) in the Great Lakes region. Can. J. Fish. Aquat. Sci. 38:1790-1807.

Joyner, S.P., L.D. Crun, R. Hastings, and R. Luginbuhl. 1985. SAS/STAT Guide for personal computers. Version 6 edition. SAS Institute Inc., Box 8000, Cary, N.C. USA, 378 p.

Kerswill, C.J. 1971. Relative rates of utilization by commercial and sport fisheries of Atlantic salmon (Salmo salar) from the Miramichi River, New Brunswick. J. Fish. Res. Board Canada 28:351-363.

Lear, W.H., and R.K. Misra. 1978. Clinal variation in scale characters of Atlantic salmon (Salmo salar) based on discriminant function analysis. J. Fish. Res. Board Can. 35:43-47.

Lear, W.H., and E.J. Sandeman. 1980. Use of scale characters and discriminant functions for identifying continental origin of Atlantic salmon. In ICES/ICNAF Joint Investigation on North Atlantic Salmon. Rapp. P.-v. Reun. Cons. Int. Explor. Mer. 176:688-75.

MacCrimmon, H.R., and R.R. Claytor. 1985. Meristic and morphometric identity of Baltic stocks of Atlantic salmon (Salmo salar). Can. J. Zool. 63: 2032-2037.

Marshall, T.L. 1979. Atlantic salmon and Canso Strait, p. 61-64. In J.S. Scott (ed.) Groundfish landings and movements related to the Strait of Canso area. Fish. and Mar. Serv. Tech. Rep. 834.

O'Neill, S.F., M. Bernard, and P.A. Gallop. 1983. 1983 Atlantic salmon commercial catch statistics: Maritime Provinces. Freshwater and Anadromous Division, Science Branch, Fisheries and Oceans, Government of Canada. 73 p.

Pella, J.J., and T.L. Robertson. 1979. Assessment of composition of stock mixtures. Fish. Bull. 77(2):387-398.

Reddin, D.G., and R.K. Misra. 1985. Hotelling's T^2 to identify the origin of Atlantic Salmon (Salmo salar) in a mixed-stock fishery. Can. J. Fish. Aquat. Sci. 42:250-255.

Saunders, R.L. 1969. Contributions of salmon from the Northwest Miramichi River, New Brunswick, to various fisheries. J. Fish. Res. Board Can. 26:269-278.

Sokal, R.R., and F.J. Rohlf. 1981. Biometry: The principles and practice of statistics in biological research, 2nd ed. W.H. Freeman and Co., San Francisco. 859 p.

Table 1. Atlantic salmon data sets comprised of known river origin and Statistical Districts 12 and 13 commercial fisheries sampled in 1983. Locations shown in Figure 1.

Location	No.	Date	Capture Method	Scale Sampling
Known river origin				
West River, Antigonish	7	Oct. 15-29	Angling	Anglers
East River, Pictou	24	Oct. 4-31	Angling	Anglers
Wallace River	10	Oct. 18-29	Angling	Anglers
River Philip	83	Oct. 6-30	Angling	Anglers
Millbank, Miramichi	59	May 9-Aug. 7	Trapnet	DFO
Black Brook, Miramichi	32	June 21-Sept. 19	Angling	Anglers
Eel Ground/Red Bank, Miramichi	17	June 8-Aug. 9	Gillnet (Native fishery)	DFO
District 13				
1 Havre Boucher	4	June 5-July 2	Trap/Gillnet	DFO
2 Bayfield	20	June 6-July 13	Trap/Gillnet	DFO
3 Lakevale	5	June 17-21	Trap/Gillnet	DFO
4 Cape George	11	July 3-13	Trap/Gillnet	DFO
5 Ballantyne's Cove	47	June 5-July 6	Trap/Gillnet	DFO
6 Livingstone Cove	26	June 18-July 7	Trap/Gillnet	DFO
7 Malignant Cove	23	June 16-July 16	Trap/Gillnet	DFO
8 Doctor's Brook	6	June 22-July 7	Trap/Gillnet	DFO
9 Arisaig	69	June 16-July 19	Trap/Gillnet	DFO
District 12				
10 Lismore	4	June 22-30	Trap/Gillnet	DFO
11 Bailey's Wharf	2	June 15	Trap/Gillnet	DFO
12 Big Island, Merigomish	42	June 16-30	Trap/Gillnet	DFO

Table 2. Scale character definitions and abbreviations used in analysis of Atlantic salmon from Statistical Districts 12 and 13, Miramichi River, New Brunswick and four Nova Scotia rivers.

Abbrevation	Definition
CR2	number of circuli along 45° axis in second river zone
DR20 DR230 DR260	distance from focus to last circulus in second river zone along 0°, 30°, and 60° axes.
CR3	number of circuli along 45° axis in third river zone
DR30 DR330 DR360	distance from focus to last circulus in third river zone along 0°, 30°, and 60° axes
CSS	number of circuli along 45° axis in first summer at sea zone
DSS0 DSS30 DSS60	distance from focus to last circulus in first summer at sea zone along 0°, 30°, and 60° axes
CSW	number of circuli along 45°axis in first winter at sea zone
DSW0 DSW30 DSW60	distance from focus to last circulus in first winter at sea zone along 0°, 30°, and 60° axes

Table 3. Age structure of known river origin Atlantic salmon, 1983.

Location	Sex	Age Group 2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	TOTAL
West River, Antigonish	♂	2			2				1		5
	♀					2					2
East River, Pictou	♂	1	8		3	6					18
	♀			1		2	2				5
	Unknown					1					1
Wallace River	♂	1	1				3	1			6
	♀							1			1
	Unknown		3								3
River Philip	♂	4	20	1	3	26	3		1	1	59
	♀		8	4	1	6	1				20
	Unknown		2			2					4
Nova Scotia Total		8	42	6	9	45	9	2	2	1	124
Miramichi											
Millbank	♂					5				1	6
	♀		7			11					18
	Unknown		15		1	19					35
Black Brook	♂					2					2
	♀		11			17					28
	Unknown					2					2
Eel Ground	♂		1								1
	♀		5		1	10					16
Miramichi Total			39		2	66				1	108
Combined Total		8	81	6	11	111	9	2	2	1	232

Table 4. Age structure of Atlantic salmon caught in Statistical Districts 12 and 13 commercial fisheries, 1983.

Location	Sex	Age Group									
		2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	4.2	TOTAL
1 Havre Boucher	♂		1								1
	♀		1	2							3
2 Bayfield	♂		3				4				7
	♀		5	1	1		6				13
3 Lakevale	Unknown		1	2			1		1		5
4 Cape George	Unknown		5	1			5				11
5 Ballantyne's Cove	♂		4	1			6				11
	♀		4	1			4	1			10
	Unknown		7	2			16	1			26
6 Livingstone's Cove	♂		6				2				8
	♀		4				9	2			15
	Unknown						3				3
7 Malignant Cove	♂		4				4				8
	♀		1				1	1			3
	Unknown		3	2			6	1			12
8 Doctor's Brook	♂		1								1
	♀		2				2				4
	Unknown		1								1
9 Arisaig	♂	1	3			1	13	1		1	20
	♀		18	2	3		11	1			35
	Unknown		4	1			6				11
10 Lismore	Unknown			1			3				4
11 Bailey's Wharf	♂			1							1
	♀						1				1
12 Big Island Merigomish	♂		4				1				5
	♀		5				1				6
	Unknown		17	7			6	1			31
Total		1	105	23	4	1	111	9	1	1	256

Table 5. Age-group means of Atlantic salmon from River Philip, Nova Scotia. * indicates characters for which differences were significant ($p < 0.01$) between age-groups. There were no differences between sexes for any characters. Abbreviations as in Table 2.

Character	Age-group 2.2	Age-group 3.2
CR2*	13.8	9.4
DR20*	32.9	24.0
DR230*	28.9	20.9
DR260*	24.4	17.3
CSS	24.1	22.4
DSS0	107.1	105.8
DSS30	91.5	90.1
DSS60	83.2	79.2
CSW	9.9	9.8
DSW0	126.2	124.3
DSW30	111.1	109.4
DSW60	95.4	92.7
Fork length, cm	77.9	76.4
Weight, kg	4.5	4.4

Table 6. Significant differences, *, ($p < 0.01$) among groups and between river ages for Atlantic salmon of known river origin from Nova Scotia East, River Philip, Millbank, Black Brook, Eel Ground, and St. Georges Bay and coastal areas of Statistical Districts 12 and 13.

	Known river origin		Statistical Districts 12 and 13	
Character	Group	River age	Group	River age
CR2	*	*		*
DR20	*	*	*	*
DR230	*	*	*	*
DR260	*	*	*	*
CR3	*			
DR30				
DR330				
DR360				
CSS	*	*		*
DSS0	*			
DSS30	*			
DSS60	*			
CSW				
DSW0	*			
DSW30	*			
DSW60	*			

Table 7. Mean fork length of Atlantic salmon of known river origin from pooled Nova Scotia and Miramichi samples, Statistical Districts 12 and 13, 1983, and Millbank trapnet, 1986. indicates groups not significantly different ($p < 0.01$) within years. There were no significant differences between sexes within groups.

Location	Sex	No.	Mean	Pooled Mean
1983				
October				
Nova Scotia	♂	60	77.2	77.3
	♀	21	77.4	
June-July				
Miramichi	♂	8	74.1	73.5
	♀	61	72.9	
Districts 12 and 13	♂	58	72.5	73.0
	♀	74	73.5	
1986				
Miramichi				
June-August	♂	15	73.5	73.9
	♀	76	74.0	
September	♂	19	75.9	74.9
	♀	46	74.4	
October	♂	5	79.9	76.7
	♀	39	76.2	

Table 8. Discriminant functions derived from "learning" samples of Atlantic salmon of known river origin. Abbreviations as in Table 2. Letters refer to learning and test data sets used in discriminant function analysis.

Age-group	Discriminant function
2.2	A) Nova Scotia = 1.51xCSS + 2.66.21xDSS30 + 974.34xDSW30 - 1270.36.
	Miramichi = 0.99xCSS + 269.32xDSS30 + 937.83xDSW30 - 1191.34.
	B) Nova Scotia = -0.17xCSS - 608.21xDSS30 + 1315.58xDSW30 - 743.00.
	Miramichi = -0.37xCSS - 602.10xDSS30 + 1299.31xDSW30 - 717.44.
3.2	C) Nova Scotia = 2.79xCSS - 78.45xDSS30 + 933.68xDSW30 - 71.00xDR230 - 875.05.
	Miramichi = 2.69xCSS - 78.97xDSS30 + 924.03xDSW30 - 74.55xDR230 - 829.90.
	D) Nova Scotia = -0.12xCSS - 5.43xDSS30 + 1320.49xDSW30 - 176.02xDR230 - 1227.40.
	Miramichi = -0.28xCSS - 19.06xDSS30 + 1313.64xDSW30 - 177.14xDR230 - 1182.44.

Table 9. Standardized coefficients for canonical variables from discriminant analysis on "learning" samples of Atlantic salmon of known river origin. Letters correspond to discriminant functions in Table 8. Abbreviations as in Table 2.

		Standardized coefficients			
Age-group	Discriminant function	CSS	DSS30	DSW30	DR230
2.2	A	0.64	-3.	44.72	
	B	0.58	-17.21	45.85	
3.2	C	0.01	0.07	1.24	0.46
	D	0.01	1.19	0.60	0.10

Table 10. Percentage of individuals in Statistical Districts 12 and 13 Atlantic salmon commercial fisheries estimated as originating within Nova Scotia or Miramichi homewaters. Percentage and 95% confidence intervals calculated from $\tilde{\theta}$ and $\Sigma\ \tilde{\theta}$ using pairs of estimates within each age-group class as described by Pella and Robertson (1979).

Age-group	Assigned origin	Percentage	95% Confidence interval
2.2	Nova Scotia	5.5	0.0- 58.4
	Miramichi	94.5	41.6-100.0
3.2	Nova Scotia	27.8	0.0- 76.1
	Miramichi	72.2	24.0-100.0

Table 11. Numbers of Atlantic salmon in each "test" sample assigned by discriminant functions in Table 9 to Nova Scotia and Miramichi origin.

Age-group	Discriminant function	Actual origin	Assigned origin: Nova Scotia	Assigned origin: Miramichi	Total	Percent Correct
2.2	A	Nova Scotia	16	4	20	80
		Miramichi	7	11	18	61
	B	Nova Scotia	16	4	20	80
		Miramichi	5	15	20	75
3.2	C	Nova Scotia	19	5	24	79
		Miramichi	9	23	32	72
	D	Nova Scotia	13	10	23	57
		Miramichi	9	21	30	70

Table 12. Numbers of Atlantic salmon from Statistical Districts 12 and 13 commercial fisheries assigned to Nova Scotia or Miramichi origin by discriminant functions in Table 9.

Age-group	Discriminant function	Assigned origin: Nova Scotia	Assigned origin: Miramichi	Percent Nova Scotia origin
2.2	A	34	69	33
	B	34	69	33
3.2	C	46	62	43
	D	39	69	36

Table 13. Summary of tagged and marked recaptures of Atlantic salmon for all age-classes of Miramichi, Margaree, and Philip rivers origin. Years refer to recapture times.

	Miramichi			Margaree		River Philip
Recapture Location	Kelts[1,2] 1931-1943	Smolts[1,3] 1955-1961	Smolts[4] 1960-1965	Kelts[1,2] 1913-1940	Smolts[2] 1976	Kelts[1,2] 1929-1943
Home river	136	2503	164	150	3	56[5]
District 2		16		110	3	2
District 3				12		
District 12						
District 13		27	17	13	2	8
District 66-76	3	2150	6			
District 77, 78, 80		38	2			
District 88			1			
Bay of Fundy		46	14			
Atlantic Coast		4	9	5		1
Newfoundland	4	305	42	22	17	7
Greenland			89		2	
Baie des Chaleurs		20	4	1		

1 No Greenland fishery at this time
2 Department of Fisheries and Oceans files
3 Kerswill (1971)
4 Saunders (1969)
5 Includes one salmon caught in Wallace River
6 Districts 2 and 3 combined
7 Districts 12 and 13 combined

Table 14. **Mean scale characteristics for 1986 Margaree and 1983 Nova Scotia East, River Philip, and Miramichi returns.**

Age-group	Location	CSS	DSS30	DSW30	DR230	No.
2.2	Margaree (1986)	19.3	90.2	106.7		4
	Nova Scotia East	24.7	85.3	104.4		13
	River Philip	23.8	91.8	111.5		34
	Miramichi	21.4	79.4	96.6		35
3.2	Margaree (1986)	18.4	85.7	104.9	20.7	18
	Nova Scotia East	21.3	84.9	103.8	19.3	23
	River Philip	22.4	91.6	110.8	20.5	38
	Miramichi	20.7	82.0	100.6	17.6	59

Table 15. **Mean temperatures from 1983 monitoring sites in areas of possible migration for Atlantic salmon caught in Statistical Districts 12 and 13 commercial fisheries and those sampled from Miramichi and Nova Scotia rivers.**

Month	District 13	Northumberland Strait	Miramichi Area	Iles de la Madelaine
June	14.6	15.0	12.2	12.8
July	16.4	17.4	15.9	15.6
August	16.1	17.6	14.8	15.7
September	15.4	16.5	14.4	14.3
October	12.9	11.7		11.6
Depth, m	14.0	7.7	11.0	4.5

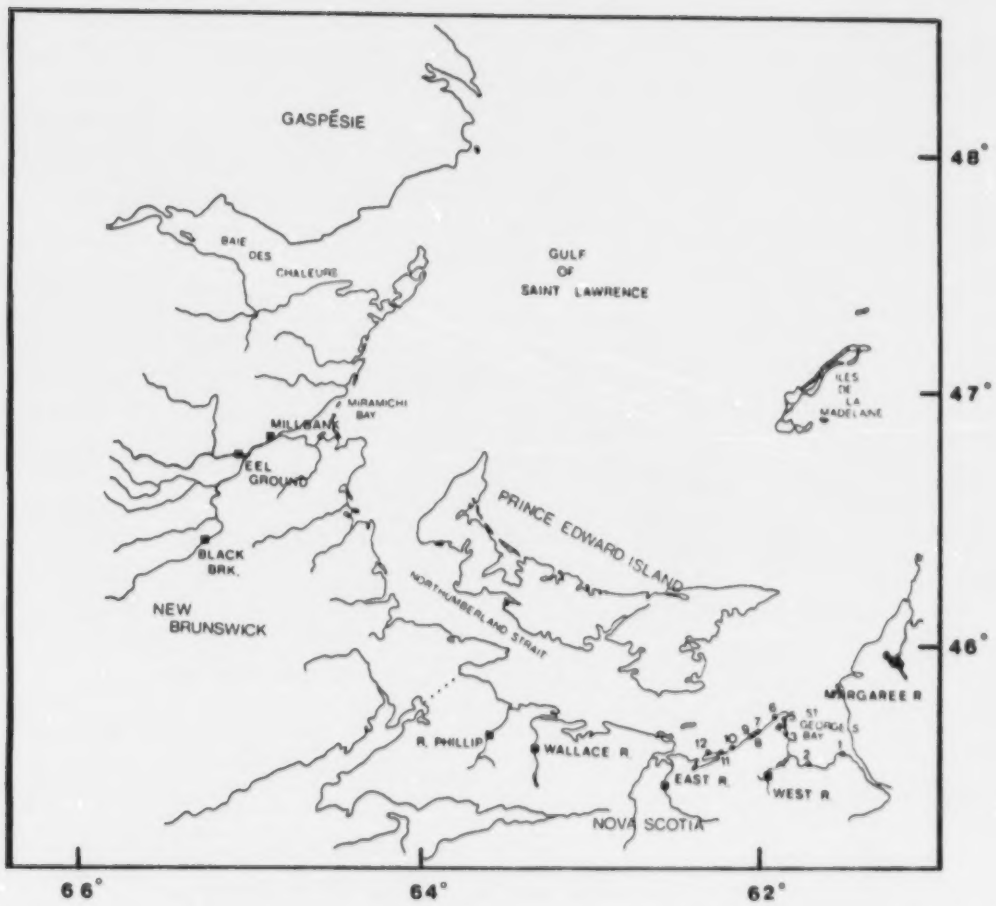
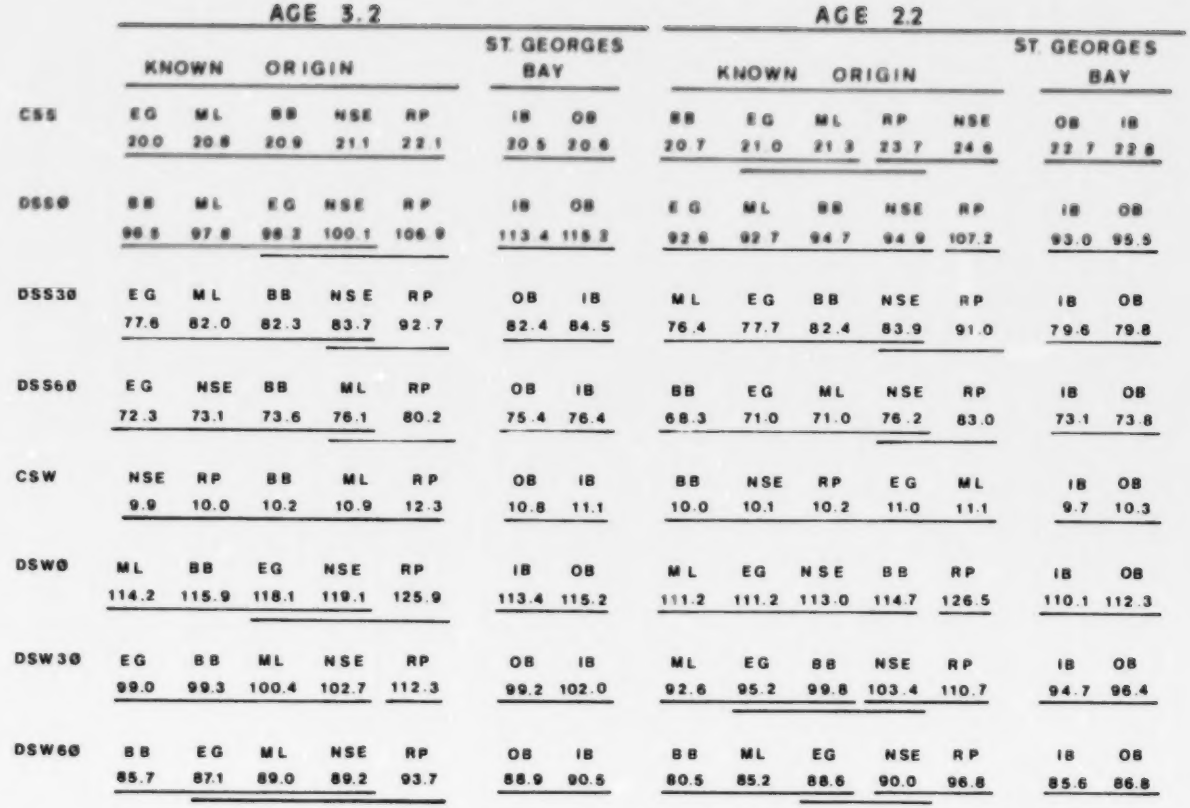


Figure 1. Location of rivers, commercial fisheries, Statistical Districts, and temperature stations sampled in 1983. Key to locations are in Table 1. SD12, Statistical District 12; SD13, Statistical District 13. Letter refers to temperature monitoring stations: A, Beach Point, PEI; B, Borden, PEI; C, Egmont, PEI; D, Victoria, PEI; E, West Point, PEI; F, Grande Entree, Iles de la Madelaine; G, Havre aux Maison, Iles de la Madelaine.

Figure 2. Means and significant differences among Atlantic salmon of known river origin and Statistical Districts 12 and 13 for freshwater zone scale characteristics. Locations sharing common line are not significantly different ($p < 0.01$). Locations are listed from lowest to highest values for each character. Character abbreviations as in Table 2. IB, St. Georges Bay sites 1-5; OB, coastal fishery sites 6-12.



	AGE 3.2							AGE 2.2						
	KNOWN ORIGIN					ST. GEORGES BAY		KNOWN ORIGIN					ST. GEORGES BAY	
CSS	EG	ML	BB	NSE	RP	IB	OB	BB	EG	ML	RP	NSE	OB	IB
	20.0	20.8	20.9	21.1	22.1	20.5	20.6	20.7	21.0	21.3	23.7	24.6	22.7	23.8
DSSØ	BB	ML	EG	NSE	RP	IB	OB	EG	ML	BB	NSE	RP	IB	OB
	96.5	97.8	98.2	100.1	106.9	113.4	115.2	92.6	92.7	94.7	94.9	107.2	93.0	95.5
DSS3Ø	EG	ML	BB	NSE	RP	OB	IB	ML	EG	BB	NSE	RP	IB	OB
	77.6	82.0	82.3	83.7	92.7	82.4	84.5	76.4	77.7	82.4	83.9	91.0	79.6	79.8
DSS6Ø	EG	NSE	BB	ML	RP	OB	IB	BB	EG	ML	NSE	RP	IB	OB
	72.3	73.1	73.6	76.1	80.2	75.4	76.4	68.3	71.0	71.0	76.2	83.0	73.1	73.8
CSW	NSE	RP	BB	ML	RP	OB	IB	BB	NSE	RP	EG	ML	IB	OB
	9.9	10.0	10.2	10.9	12.3	10.8	11.1	10.0	10.1	10.2	11.0	11.1	9.7	10.3
DSWØ	ML	BB	EG	NSE	RP	IB	OB	ML	EG	NSE	BB	RP	IB	OB
	114.2	115.9	118.1	119.1	125.9	113.4	115.2	111.2	111.2	113.0	114.7	126.5	110.1	112.3
DSW3Ø	EG	BB	ML	NSE	RP	OB	IB	ML	EG	BB	NSE	RP	IB	OB
	99.0	99.3	100.4	102.7	112.3	99.2	102.0	92.6	95.2	99.8	103.4	110.7	94.7	96.4
DSW6Ø	BB	EG	ML	NSE	RP	OB	IB	BB	ML	EG	NSE	RP	IB	OB
	85.7	87.1	89.0	89.2	93.7	88.9	90.5	80.5	85.2	88.6	90.0	96.8	85.6	86.8

Figure 3. Means and significant differences among Atlantic salmon of known river origin and Statistical Districts 12 and 13 for sea zone scale characteristics. Locations sharing common line are not significantly different ($p < 0.01$). Locations are listed from lowest to highest values for each character. Character abbreviations as in Table 2. IB, St. Georges Bay sites 1-5; OB, coastal fishery sites 6-12.